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Blockchains – A Valuable Commercial Contribution or a Romanticized Technology Playground?

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Technology and Terms
Applications
Perceptions and Findings

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Introduction

- Databases

  - Data organized in schemata
  - Access control for users and the “SysAdmin” (trusted root)
    - Centralized, physical, and trusted servers are maintained

→ Potentially central point of failure, loss, or misuse

  - SQL-based systems
    - MySQL, MariaDB, PostgreSQL, Oracle DB, MSSQL, …

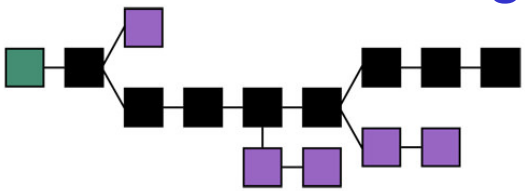
  - NoSQL-based systems
    - Hadoop/HBase, Cassandra, MongoDB, Redis, …

Decentralization

- Decentralized databases
  - Available and used in production
  - Every copy runs on a trusted node
  - But, users (stakeholders) are known/registered

- Can data be stored fully decentralized and handled reliably between non-trusted stakeholders?
  - Unstructured or structured data
  - Access control by “all” without a central root
  - Storage “across the world” by anyone
  - **No central point** of failure, redundant copies in place, non-trusted participants, detectable misuse

→ Distributed Ledger



Blockchain Definition and Basics

- Distributed Ledgers or Blockchains (technology)
  - Digital record of who-owns-what w/o a central storage
    - Ledger is replicated among nodes in a distributed network

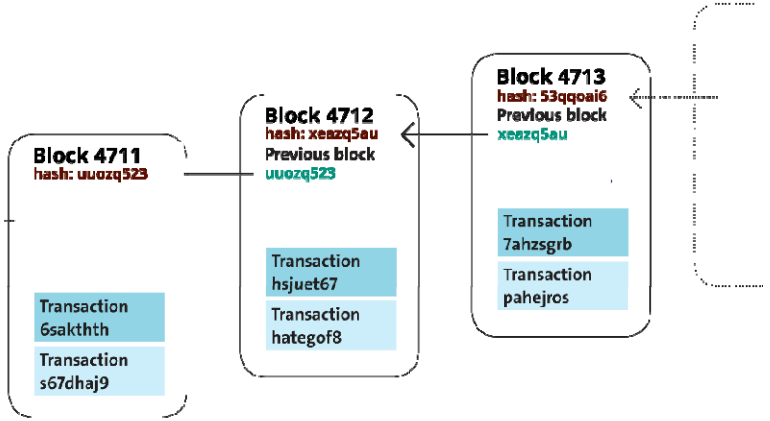
- Consensus algorithm ensures that each node‘s copy of the ledger is identical to every other node’s copy

- Access to ledgers from asset owners for transactions via cryptographic signatures and by miners with large compute power (PoW) to

  - persist “incoming” data (token=assets) on a (private or) public ledger
  - read/offer “outgoing” data to any other stakeholder (non-private)
- Advantages of distributed ledgers:
  - Unforgeable, traceable, and preventing “double spending”

Blockchain Operations

- Transactions collected in blocks
  - New blocks created regularly
- A block contains a pointer to the previous block → Blockchain!



- Consensus mechanism required to determine the block to be integrated into the blockchain
  - Public blocks typically contain solved crypto puzzles
    - *E.g.*, a form of partial hash collisions (SHA256)

- Creation of valid blocks is called mining (reward)
  - Computational expensive → Avoids double spending
  - Mining ≡ confirmation of blocks ≡ solving crypto puzzles

Smart Contracts

- A Smart Contract (SC) resides inside transactions
  - Executed and validated on every node
  - In Bitcoin (a blockchain-based crypto-currency), SCs specify how to withdraw, escrow, refund, or transfer BTC from A to B
- SCs first mentioned in 1994

> A smart contract is a **computerized transaction protocol** that **executes** the terms of a contract. The general objectives of [a] smart contract['s] design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and **minimize the need for trusted intermediaries**. Related economic goals include **lowering fraud loss, arbitrations and enforcement costs, and other transaction costs**.
>
> **N. Szabo**

- Smart contracts alone are not "smart"
  - They need an infrastructure (technology)
  - A blockchain is ***the*** ideal technology for SCs
- The legal relevance of "coded", more general contracts?

First Practical and General Smart Contracts

- SCs for a crypto-currency, *e.g.*, the Bitcoin scripts
  - Are not Turing-complete
  - Show slow developments and slow feature integration
  - Are characterized by slow consensus finding in its community
- General purpose SCs are needed
  - Ethereum enables Turing-complete SCs
    - Beta Frontier July 2015, Homestead Release March 14, 2016,
    - Hard fork July 20, 2016 after DAO (investor-directed venture capital fund)
  - Permissioned blockchains based on Ethereum
    - Monax (Eris:db) with an additional permission layer
  - Other non-Ethereum-based (target on fast clearing, settlement)
    - Originally R3 Corda: fintech members, “quieter” since mid 2017

Applications

Application Example 1 – Bitcoin

- Bitcoin is an experimental cryptographic currency
  - Bitcoin is fully peer-to-peer (no central entity, trustless)

  → Blockchains applied to reach this goal (sic!)
  - 1st Bitcoin issued on January 3, 2009

- Key characteristics (for a maximum of 21 million BTC)
  - Every transaction broadcast to all peers
    - Every peers knows all transactions (~160 GByte as of Nov 2017)
    - Maximum of 7, real life 3-4 transactions per second (1 MB block size)
  - Validation by Proof-of-Work (PoW) consensus mechanism
    - Partial hash collisions, thus, very difficult to fake this type of PoW
- 2nd Hard fork on Oct 25, 2017 into “Bitcoin gold“
  - To be “mineable“ by more people with less powerful hardware

Application Domains – Examples

	Assets		Domain	
	dig.	tang.	fin.	other
Governmental services – Registry of deeds, eVoting, …	X	X	(X)	X
Trading/banking services – Diamonds, cash-heavy, …	X	X	X	(X)
Copyright – Authorship, ownership, …	X	(X)		X
Data and identity management – Records, processes, compliance	X	(X)		X
“Chain” support/IoT services – Supply, food, energy, …	(X)	X	X	X
Entertainment	X			X
Cryptocurrencies	X		X	

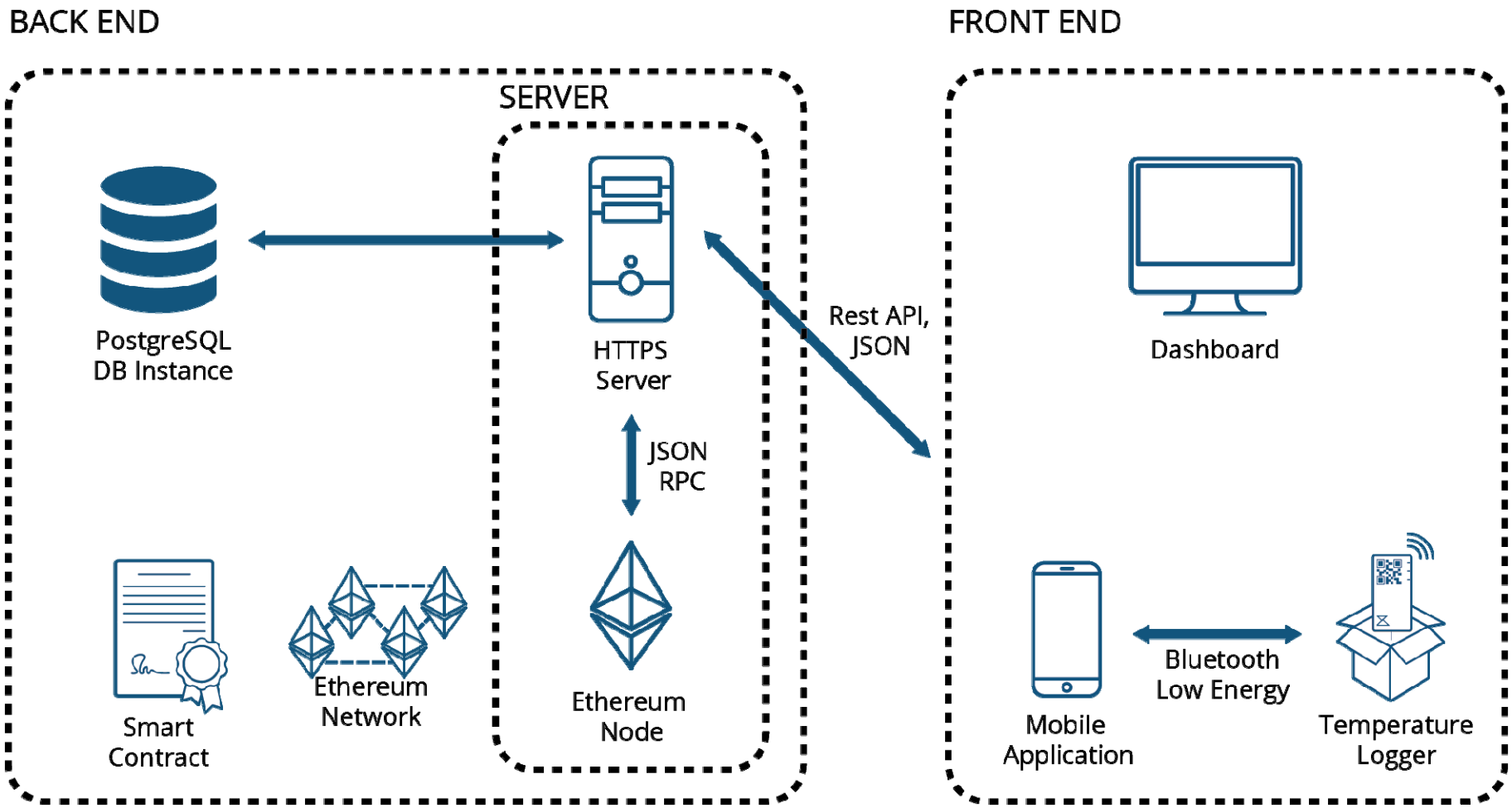
Application Example 2 – Coldchains

- Pharmaceutical sector (supply chain)
  - More than 200 million yearly shipments of medical drugs inside of the EU and associated countries

  - 100% monitoring of transport required due to EU regulation
    - "Good Distribution Practice of medicinal products for human use" (GDP 2013/C 343/01) since January 2016

    - Package: Post 6 CHF, cooled transport 35 CHF → cost saving's factor 6
    - 60% of medical drugs are not even temperature-sensitive!
- Solution (incl. vendors, logistic, wholesale, authorities)
  - Blockchain-based Coldchains (BC4CC) to store temperature data monitored, execute smart contracts on those upon arrival
    - Direct authority access, unknown stakeholdes can participate

Blockchains for Coldchains Architecture



Developed by CSG@IfI, serves as foundation for modum.io UZH start-up

Perceptions and Findings

(preliminary – as of today)

General Perception of Blockchains

- Stakeholders involved in (public) blockchains are
  - everyone on the globe (potentially) with Internet access
  - unknown to each other, without any central authority

- First "appearance" of blockchains
  - In the context of Bitcoin in 2009
    - First real and experimental crypto-currency
  - Transactions determine data of payments to be persisted, while solving the double spending of electronic "coins"

Very limited view

- Generalization of non-trusted stakeholder interactions for unforgeable data persistence
  - Considered to be a disruptive technology?

More general view

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Concerns and Risks (1)

- General
  - Handling of tangible (non-digital) assets: proof of asset‘s ownership? Secure mapping of tangible to digital asset?
  - Societal and governmental acceptance?
    - Cryptocurrency bans, ICO as “illegal activity”, asset mapping fraud
- Technology
  - Breaking of applied security algorithms (long-term storage, if signing algorithms will be broken?)
    - Security impacts due to alternative consensus mechanisms?
  - Unknown attack vectors and programming errors
    - Privacy: persisted data at stake?
  - Efficiency of consensus mechanisms
    - Energy consumption for Bitcoin alone required in 2015 ≈ Mühleberg‘s energy production

Concerns and Risks (2)

- Operations
  - Scalability: Throughput as number of transactions per sec?
    Volume of data persisted, not bytes but MB?
    Chain sizes grow faster than density of HDDs/SSDs!
  - Delay: Latency of persisting steps, block sizes?
  - Implications on privacy: access rights and management?
  - Lacking Internet connectivity for a “longer” period of time?
  - Standardized APIs for switching applications on top of blockchains at minimal costs (“lock-in” effects?)
- Economics
  - Stability of coin/token value against fiat currency: volatility?
  - No prevention of making fraudulent profitability projections
  - Role, interrelationships of more than1000 crypto-currencies?

Observations

- Distributed apps show a larger coordination effort

- Blockchain's cost/benefit perspective (incentives)
  - Costs: known in advance (*e.g.*, HW, VM, network, setup, or fees)
  - Benefits: less "central" infrastructure plus "unknown" soft factors

- Once risks are mitigated and legal/regulatory constrains are known, apps *may* benefit from blockchains, but
  - How to address value destruction problems?
  - ICO vs. traditional emission rules may harm?
  - Country-specific rules will become "international" obstacles?

- Dedicated apps maintaining inherently digital assets do show a much larger (disruption) potential
  - Solving the "media break" may increase this potential

Important to Remember

- Blockchain (technology) is potentially able to

Commercial Contribution

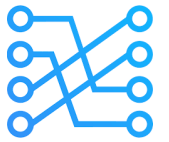
  - change existing legal contracts including a or multiple trusted third party(ies), *e.g.*, by “replacing“
    - Banks as transaction mediator for fund/Fintech transfers
    - Notaries as mediation of two or more stakeholders, incl. enforcement

→ Trusted communications (incl. documents) are persisted, but no counseling is stored

Romanticized Playground

  - persist ***digital*** assets, but not limited to (?) including, *e.g.*,
    - Property, driving licenses, art, diamonds, meat, objects, ...

→ Trusted communications & persisted storage of assets could offer automated operations of ownership and validity checks, ***but*** lack the proof-of-ownership due to secure mapping problems of tangible assets to digital tokens



Thank you for your attention.